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(56) Documents cited
GB 2192067 A GB 2143954 A GB 2136138 A

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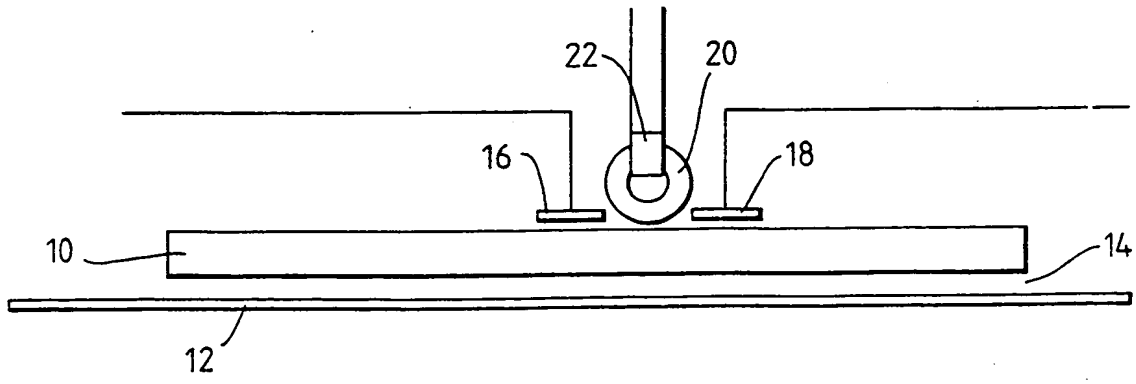
(54) Testing unpopulated printed circuit boards

(57) In an arrangement for testing an unpopulated printed circuit board (10), r.f. energy is coupled (16) into successive localities in the board and a low frequency perturbation of the electromagnetic field is set up (20) at each locality. The resulting modulation of the electromagnetic field at each locality is detected (18) and compared with an expected value. As shown, ferrite cores (20) produce perturbations at 1kHz, but it is envisaged that a laser or an ultra sound source could be used instead.

Fig. 2.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

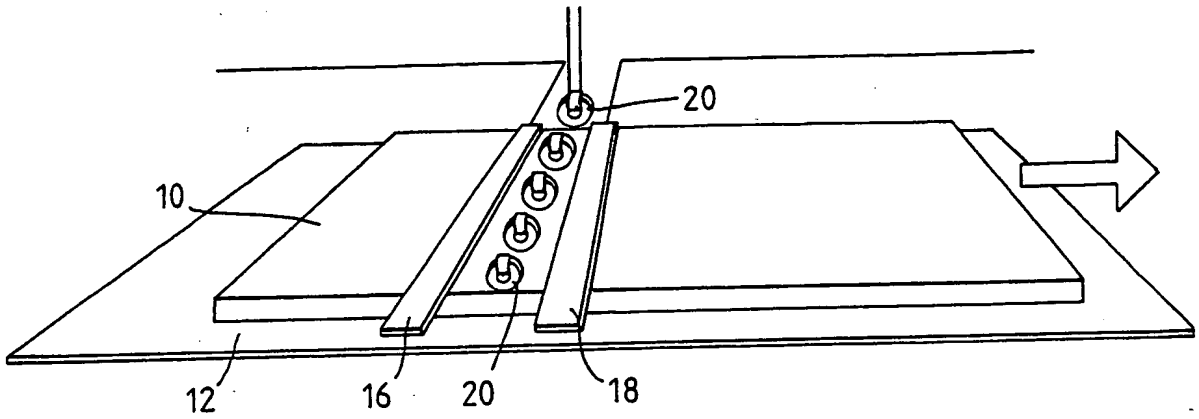


Fig.2.

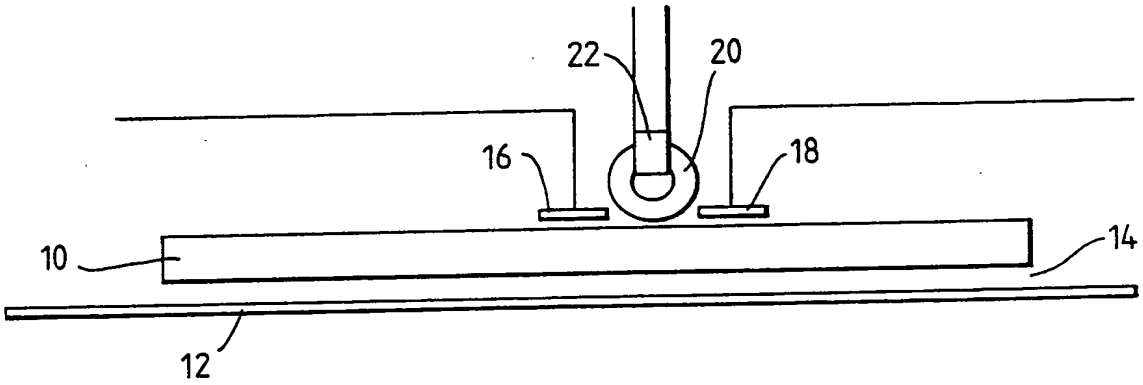
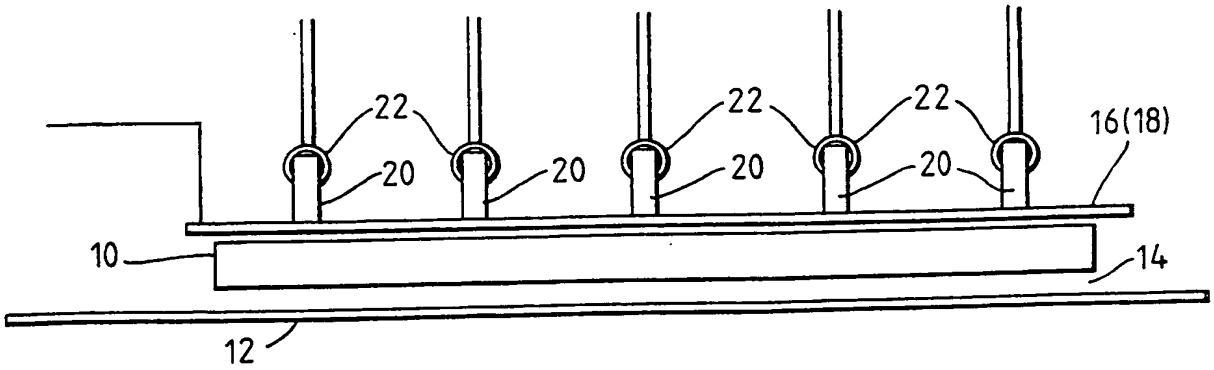


Fig.3.



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Monitoring quality of unpopulated printed circuit boards

This invention relates to an arrangement and method for monitoring the quality of unpopulated printed circuit boards.

As printed circuit boards are made more complicated with multilayers and vias, it becomes imperative to be able to monitor the quality of printed circuit boards before it gets populated with components. From an electrical standpoint there must be integrity of the conductive tracks; the board must be free of breaks in a track or via and free also of shorts between tracks.

One way of investigating a multilayer board is to take an X-ray, which should reveal all the features inside. This, however, is very difficult to interpret accurately and cannot easily be automated. The obvious method of checking the electrical performance of a printed circuit board is to send signals through it. Here the problem is getting the signals in and out of the board when some tracks might lie in the middle of the board and may be of short length.

According to the present invention there is provided a method of testing an unpopulated circuit board, the method including the steps of coupling r.f. energy into localities of the circuit board, effecting a low frequency perturbation of the electromagnetic field set up in the vicinity of the localities and comparing the resultant modulation of the electromagnetic field at each locality with an expected value.

The invention also provides an arrangement for monitoring the quality of an unpopulated circuit board, the arrangement including means for coupling r.f. energy into localities in the printed circuit board, means for perturbing at a low frequency the electromagnetic field set up in the vicinity of each locality, means for detecting the resulting modulation of the electromagnetic field at each locality and means for comparing the resulting modulation of the electromagnetic field at each locality with an expected value.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a perspective view of an arrangement for monitoring the quality of an unpopulated printed circuit boards;

Fig. 2 is a side elevation view of the arrangement of Fig. 1, and

Fig. 3 is an end elevation view of the arrangement of Fig. 1.

In the arrangement depicted an unpopulated printed circuit board 10 is placed above, and electrically insulated from, and earth plane 12, e.g. a sheet of metal. Placed over the printed circuit board 10, and spaced therefrom by an airgap 14, or a thin sheet (not shown) of dielectric material, are first and second strip conductors 16, 18 between which are positioned a line of closely spaced ferrite toroidal cores 20. Each ferrite core is wound with a coil 22. Radio frequency energy, e.g. 0.5-10GHz, is applied to the strip conductor 16 and the strip conductor 18 is coupled to a detection circuit (not shown). A low frequency signal, e.g. 1KHz, is applied to the ferrite coils in sequence. In use, the combination of strip conductors 16, 18 and line of ferrite cores 20 is moved across the printed circuit board (or vice versa) in a direction normal to the axes of the conductor strips and the line of ferrites.

The r.f. energy in the strip 16 is capacitively coupled

into the printed circuit elements on and in the printed circuit board 10. Because a complex printed circuit board contains a large number of closely spaced conductive tracks the r.f. energy will couple into the track structure of the board very effectively. Furthermore, there will be sufficient coupling between adjacent tracks within the printed circuit board to enable the r.f. signal to propagate from the first strip conductor 16 to the second strip conductor 18. The sequential energising of the ferrite cores causes the electromagnetic field created by the r.f. signal below and between the strip conductors to be perturbed, thus effectively modulating the signal received at the strip conductor 18. This modulation can be detected, the ferrite cores acting as scatterers of the local electromagnetic field set up by the r.f. signal.

Because the ferrites are sequentially energised, and the apparatus is moved in relation to the board, the board is effectively scanned in sequential rows, each row being scanned in a number of localities corresponding to the disposition of the ferrite cores. Thus a 'signature' or 'finger-print' of a correct or fault-free board can be produced which is unique to that board, analogous to that produced in a conventional S-parameter measurement system. The signature of each subsequent board can be compared with this board signature, any defects such as shorts or open-circuits in the board being detected as alterations to the signature.

The combination of the strip conductors 16, 18 and the line of ferrite cores 20 can be conveniently fabricated as an integral head. In an alternative arrangement a single ferrite core 20 can be incorporated in a scanning device which reciprocates orthogonally to the movement of the strip conductors over the board, in a manner analogous to a scanning of a document in a facsimile machine. Other variants will readily be apparent to those skilled in the art. For example, reflected signals can be coupled out of the strip conductor 16 in addition to the forward signals coupled out of strip conductor 18. Perturbing ferrite cores can be placed on both sides of the board to increase sensitivity.

The r.f. signal frequency can be tuned to resonant frequencies within the track structure in the board, thus enhancing the detection of anomalies. The monitoring of the board can be effected at elevated or reduced temperatures, thus enabling the monitoring of failures due to expansion mis-matches. Ordinarily the two microstrip lines 16, 18 would normally be terminated with 50 and have a length of an odd number of quarter wavelengths for maximum coupling. The lines could alternatively be terminated with open or short circuits to create standing wave patterns within the lines. By sweeping the voltage r.f. maxima of the standing wave can be positioned, thus enhancing the sensitivity at a particular location. In moving the board under the microstrips during measurement, the board could by means of suitable rollers, be flexed so that potential structural problems will be revealed. Other methods of peturbing the electromagnetic field may be available, e.g. applying a pulsed laser to cause localised intermittent heating of dielectric material thereby altering its characteristics, or subjecting dielectric material to ultrasound, again to alter its characteristics when it is within the field.

CLAIMS

1. A method of testing an unpopulated circuit board, the method including the steps of coupling r.f. energy into localities of the circuit board, effecting a low frequency perturbation of the electromagnetic field set up in the vicinity of the localities and comparing the resultant modulation of the electromagnetic field at each locality with an expected value.

2. A method according to claim 1 wherein said r.f. energy is in the Gigaherz range and the perturbing low frequency is in the audio range.

3. A method according to claim 1 or 2 wherein the detected resultant modulation forms a signature unique to the board and this signature is compared to the signature of a known fault-free board.

4. Amethod according to claim 1, 2 or 3 wherein the r.f. energy is capacitively coupled into the board in successive different localities.

5. A method of monitoring the quality of an unpopulated printed circuit board substantially as hereinbefore described.

6. An arrangement for monitoring the quality of an unpopulated circuit board, the arrangement including means for coupling r.f. energy into localities in the printed circuit board, means for perturbing at a low frequency the electromagnetic field set up in the vicinity of each locality, means for detecting the resulting modulation of the electromagnetic field at each locality and means for comparing the resulting modulation of the electromagnetic field at each locality with an expected value.

7. An arrangement according to claim 6 wherein the means for coupling r.f. energy into the board and means for detecting resulting modulation comprise first and second strip conductors in a fixed parallel relationship adapted to be spaced from a major surface of the board such that relative movement between the strip conductors and the board effects a scanning of the board surface, the means for perturbing being positioned between said first and second strip conductors.

8. An arrangement according to claim 7 wherein said perturbing comprises one or more coil wound ferrite cores to which

low frequency signals are fed.

9. An arrangement according to claim 8 wherein a single ferrite core is reciprocated in a direction parallel to the orientation of the strip conductors while the relative movement of the strip conductors relative to the board is orthogonal to said reciprocation.

10. An arrangement according to any one of claims 6 to 9 including means for coupling out of said r.f. capacitive coupling means reflected signals resulting from the modulation of the electromagnetic field.

11. An arrangement according to any one of claims 6 to 10 wherein said r.f. energy capacitively coupled into the board is tuned to different frequencies during monitoring of the board.

12. An arrangement according to any one of claims 6 to 11 including means for flexing the board during monitoring of the board.

13. An arrangement according to any one of claims 6 t0 12 including a second means for perturbing positioned in a corresponding position on the opposite side of the board to the first means for perturbing.

14. An arrangement according to any one of claims 6 to 13 wherein the board is spaced from an earth plane on the opposite side of the board to the capacitive coupling means, perturbing means and detecting means.

15. An arrangement for monitoring the quality of an unpopulated printed circuit board substantially as described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) G01R 31/00

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Search Examiner
K F J NEAL

Date of Search
14 SEPTEMBER 1992

Documents considered relevant following a search in respect of claims 1-15

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2192067 A (NRDC) - Figure 4 abstract	
A	GB 2143954 A (SHARETREE) - Figure 3 abstract	
A	GB 2136138 A (KOLLMORGAN) - Figure 1 abstract	

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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